

ABUNDANCE AND DENSITY OF THE FRESHWATER PEARL MUSSEL *MARGARITIFERA MARGARITIFERA* IN RIVERS OF NORTHWEST RUSSIA IN THE PERIOD FROM 1971 TO 1979

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The paper presents data from the studies of the distribution range of the mussel *Margaritifera margaritifera* carried out in 1970–1979. **Novgorod Region.** *M. margaritifera* still inhabited the upper courses of the rivers least affected by the industry, which originate from Valdai hills, for example, Polomet', Horinka. **Leningrad Region.** No *M. margaritifera* found in rivers of the Ladoga Lake drainage basin, such as Ojat', Pasha, Kapsha, although spawning of salmonids is common throughout. **Arkhangelsk Region and Karelia.** *M. margaritifera* was found in several rivers. In the Keret' River, which used to be a centre of pearl harvesting until the late 19th century, colonies of *M. margaritifera* were present only in the lower reaches. No mussels were found in another large river of the White Sea basin – Kem', although both rivers had been used for timber rafting up until the 1960s. Both rivers still contain salmon spawning areas. In the Arkhangelsk Region, colonies of the mussel with a density of up to 50 ind./m² were found in the Kazanka River, with hardly any pearl mussels present in the numerous tributaries of Severnaya (Northern) Dvina or on the southern coast of the White Sea. **Kola Peninsula.** Colonies of *M. margaritifera* were detected in the transboundary (Russia, Finland and Norway) Petsojoki River system. Extensive populations of *M. margaritifera* were found in many tributaries of the Tuloma River, which also originates in Finland. Examples of rivers with well-preserved pearl mussel populations are the Kola River (Barents Sea watershed), and the Varzuga River with its tributary Pana (White Sea watershed). Centuries of human pressure have resulted in near extinction of the mussel *M. margaritifera* from the majority of rivers of Northwest Russia.

Key words: Northwest Russia, freshwater pearl mussel, abundance

INTRODUCTION

The history of Russian pearls in the territory of Russia is mainly bound to the Northwest of the country. Peter the Great showed particular interest in northern pearls (Alopeus, 1787; Kazanskiy, 1891). In his decree issued on July 8, 1721 he prohibited both peasants and landowners to fish for pearls in Novgorod Province, Rzhev and Toropets provinces. Only state servants could harvest pearls. However, a new decree was issued just a year later. It allowed anyone to fish for pearls without restrictions under the condition that all the pearls collected were delivered to the Board of Commerce. Three quarters of the value of the pearls were paid to the fisher, and the state received the remaining quarter.

After the revolution of 1917, a few attempts were taken to investigate the populations of *Margaritifera margaritifera* in Northwest Russia. Thorough studies of the state of *M. margaritifera* populations in rivers of the Kola-Karelian region were carried out by Vereshchagin (1929).

Industrial development in the Northwest of the USSR, including logging and construction of numerous hydropower plants, has led to extinction of *M. margaritifera* from many waterbodies (Korago, 1981). One should note however that the surveys carried out in the Soviet period (Vereshchagin, 1929; Vlasov, 1934; Gaevskiy, 1926; Golubev et al., 1973; Golubev et al., 1974; Graevskiy et al., 1949; Zhadin, 1939) prove large colonies of *M. margaritifera* were present in many rivers of Northwest Russia.

Below we present data on the distribution range of *M. margaritifera*, and the state of its populations in specific rivers of Northwest Russia in 1970–1979. The data remained unpublished for many years as they were property of the Ministry of Geology and the Jewelry Industry. We thought it wise to make data on the history of studies of the mussel's range more complete.

In 1969, the jewelry industry administration of the USSR charged one of the authors of the present paper with the task to assess the freshwater pearl mussel stocks in Northwest Russia.

The question was quite natural because rivers of the region have for several centuries (up to the 20th century) supplied jewelry pearls to the imperial court and to the Church.

To fulfill the task, the following had to be done:

1. Determine current boundaries of *M. margaritifera* range.
2. Estimate the stocks in the watercourses where pearl mussel populations were in good condition.

MATERIALS AND METHODS

According to archival data, distribution of the freshwater pearl mussel *M. margaritifera* in Russia is bounded in the south by Valdai hills. In the north, the mussel's distribution is limited by the White Sea and the Barents Sea.

The following conventional subdivision of the range from south to north can be made:

1. Rivers of Lake Ilmen' drainage basin (Novgorod Region).
2. River systems of Lake Ladoga and the Gulf of Finland (Leningrad Region).
3. Rivers of Lake Onego drainage basin and transboundary water systems of Finland and Karelia, as well as rivers of the White Sea basin (Arkhangelsk Region).
4. Rivers of the Kola Peninsula.

The amount of factual material amassed over the 10 years of research is quite extensive, wherefore we shall limit ourselves to general data on the above zones, with some typical examples.

Most of the rivers were surveyed throughout, from source to mouth. The bottom of the rivers was examined from a boat through the «Korean window» (a box with glass). Every kilometre, the bottom was surveyed by divers for exact counts of mussels in sample plots (1 m²). All sample plots were mapped, indicating the number and coordinates.

Sites of certain length and width were marked out in localities with the greatest numbers of mussels. E.g., length – 1 000 m; width (according to 6 measurements) – 50 m. Area $S=1000 \times 50=50\,000$ m². Mean density of *M. margaritifera* micropopulations within such sites averaged for 18 sample plots was 13 ind./m². Thus, the total number of mussels per site was $50\,000 \times 13 = 650\,000$ individuals.

DISCUSSION

According to historical data, *M. margaritifera* range is bound in the south by sources of the rivers Shelon', Lovat' and Msta of the Lake Ilmen' drainage basin. Watersheds of these rivers have for centuries been exposed to heavy human pressure: logging, timber floating, agriculture, etc. These activities could not but tell on the water chemical composition, reduce fish stocks, which are an obligatory phase in *M. margaritifera* life cycle, and, hence, reduce the mussel numbers.

Indeed, *M. margaritifera* has survived only in the headwaters of the rivers which originate from Valdai hills, and were least affected by industrial impact. These are small rivers – Polomet', Horinka (Fig. 1).

The surveys were rather unrewarding, given that less than one per cent of the thousand kilometres surveyed yielded some finds, and even there the state of the populations was far from optimal.

There remained either isolated colonies (Kulotina River – density up to 10 ind./m²) or individual mussels (Rivers Reglinka, Yaryn'ya).

Another area where the pearl mussel may be present, judging by historical data, is rivers of the Ladoga Lake catchment, such as Ojat', Pasha, Kapsha (Fig. 2). The drainage basins of these rivers, including tributaries, were fully surveyed, up to the sources. No *M. margaritifera* was found, although salmonids spawned throughout the area. Intensive timber floating that had taken place there for most of the historical period could be the cause of the mussel's extinction. Drilling of the Ojat' riverbed showed silted tree trunks constitute the bottom sometimes up to several metres in depth. The map demonstrates how thoroughly the rivers were investigated.

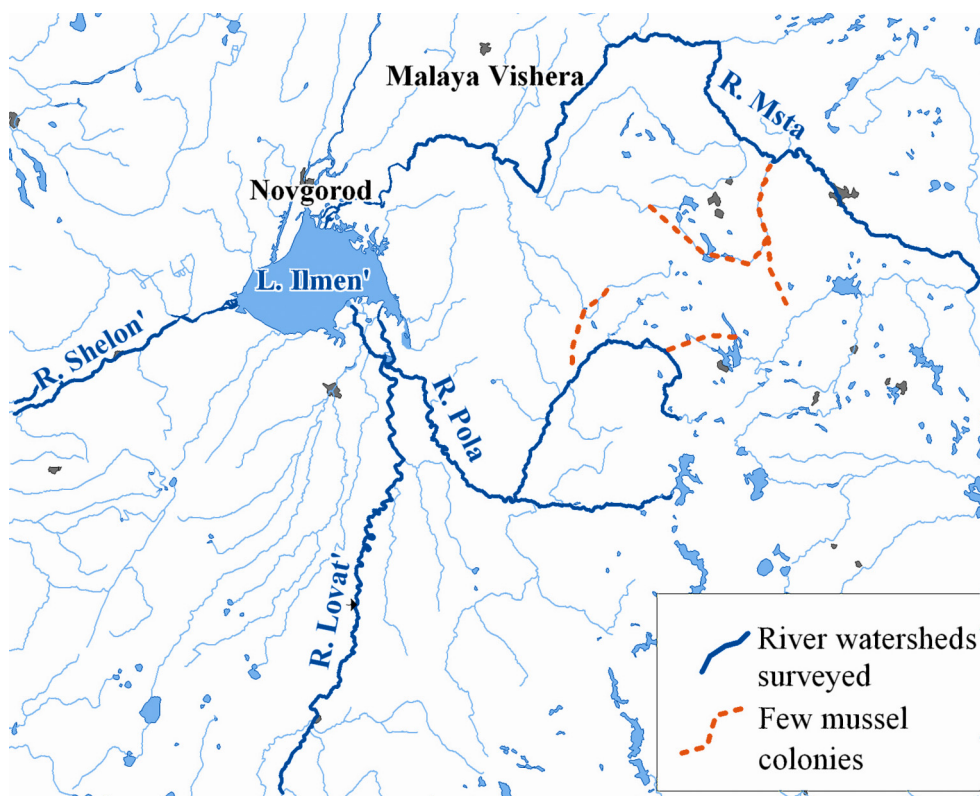


Fig. 1. Rivers surveyed in Lake Ilmen' drainage basin (Novgorod Region)



Fig. 2. Rivers surveyed in Leningrad Region *M. margaritifera* was found in the lower reaches of the Olonka River, where its density was 1–3 ind./m²

The same zone includes small rivers flowing to the Gulf of Finland, and rivers of the Vuoksa system, which contained occasional mussel individuals.

River systems of Lake Onego and the White Sea used to be known for wide occurrence of *M. margaritifera*, and as natural spawning areas of salmonids.

The fate of forest stock in Karelia and Arkhangelsk Region is notorious. In the 1950s–1970s, in addition to conventional logging, the forests were chemically treated from the air. Quite expectedly, *M. margaritifera* populations in the region were severely affected. Only specialized studies can disclose the factors that have enabled survival of some populations. E.g., the Nemina River (Lake Onego): lower reaches (20 km surveyed) – no mussels; middle reaches (15 km surveyed) – *M. margaritifera* colonies with a mean density of 20 ind./m²; headwaters (20 km surveyed) – no mussels.

The Keret' River (White Sea) is an old pearl fishing area. No mussels were found in the headwaters (250 km stretch). *M. margaritifera* colonies in good condition (50 ind./m²) were detected in the lower reaches, both in still and in rapid sites (Fig. 3).



Fig. 3. Rivers surveyed in the drainage basins of Lake Onego (Karelia), and the White Sea (Arkhangelsk Region)

A well-known drainage basin south of Keret' is the Kem' River, which has a great number of tributaries. The combined length of the survey routes on the river and its tributaries was more than 500 km. No *M. margaritifera* was found. Note here that until the 1960s timber floating had been very intensive both on Kem' and on Keret'. Salmonids still spawn in both rivers (Fig. 3).

In Arkhangelsk Region, mussel colonies with a density of up to 50 ind./m² were found in the Kazanka River. At the same time, hardly any mussels were present in the numerous affluences of the Severnaya Dvina River basin and the White Sea southern coast.

Kola Peninsula is the northernmost part of *M. margaritifera* distribution range. It all lies north of the Polar Circle. In contrast to southerner areas, there had been no agriculture or logging until the 19th century, whereas salmonids were widespread there.

Keeping these factors in mind, we assumed *M. margaritifera* populations have survived in their historical habitats in the region. These are rivers of the White Sea watershed: Umba, Varzuga, Olennitsa, Pyalitsa, Strel'na, etc., and rivers of the Barents Sea watershed: Jokanga, Voron'ya, Kola, Tuloma, Zapadnaya Litsa, Pechenga, etc. Sources of the Tuloma River, just like rivers Lotta, Iotta, etc. are also of interest as transboundary watersheds (shared with Finland).

Data from surveys of the Kola Peninsula rivers are presented in Fig. 4 and Tab. 1.

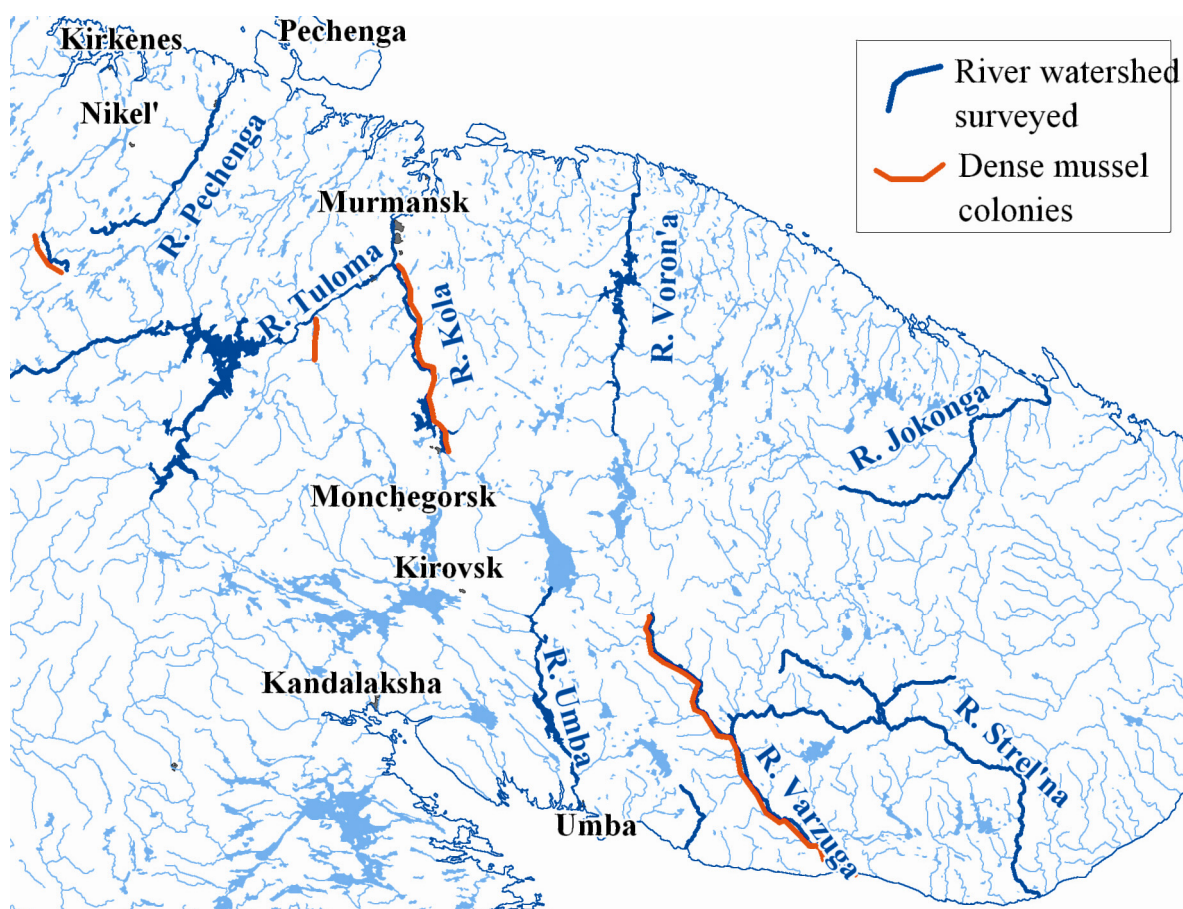


Fig. 4. Surveyed rivers of the Kola Peninsula

The Petsojoki River system is a water system of the lake-river type. It originates from Finland, from Lake Inari, and empties into the Barents Sea near the Norwegian city of Neiden. The right-side tributary of Petsojoki – the 36-km long River Nautsijoki, was surveyed. *M. margaritifera* was present in 30 km of the channel. The population density ranged from 1–5 to 17 ind./m² in the lower reaches; the size of the shells was up to 10–12 cm. The mussels were counted in a 100x50 m sample plot in the river downstream, and the result was 650 000 individuals.

Table 1. Surveys of the Kola Peninsula rivers for the mussel *Margaritifera margaritifera*

Drainage basin	Water system	River	Extent of survey routes, km	Presence of mussels
Barents Sea	R. Pechenga	Bolshaya Pechenga	72	absent
		7 tributaries	130	absent
	R. Petsojoki	Nautsijoki	32	Population in good condition
	R. Tuloma	Malaya Kitsa	16	absent
		Bol'shaya Kitsa	21	absent
		Kola	66	Population in good condition
		Pecha	57	Occasional mussels in the tributaries Kolna, Koodysh
		Nota	138	absent
		Yavr	20	absent
		Girvas	14	absent
		Lotta	113	Declining colonies with an average density of 1 ind./m ² , no young mussels
		Ulita	31	Population in good condition; the average density of a colony is 15 ind./m ²
White Sea	R. Umba	Umba	50	13 km in the headwaters populated with the mussel (1 ind./m ²); declining colonies
	R. Strel'na	Strel'na	250	absent
	R. Varzuga	Varzuga	290	Population in good condition
		Pana	135	Population in good condition

Tuloma River system.

The Kola River merged with the Tuloma in its mouth, near Murmansk. Mussels were present in 61 km of the river.

The Ulita River is a right-side tributary, which joins Tuloma in its middle reaches. The mussels were first noted at the confluence with its right-side tributary Gal'sha, and were then present throughout. The population density ranged from 1–2 to 12–15 ind./m².

The Umba River is a lake-type river 122 km long, originating from Lake Umbozero. The river has a step-wise profile typical of all rivers of the peninsula: still and rapid sections alternate. The water level is regulated by lakes; the river in general is shallow; it was used for timber floating. *M. margaritifera* began occurring 11 km from the source and was present for 13 km downstream. The population density was 1 ind./m² – the colonies are declining.

River Varzuga. The channel is 290 km long. The headwaters flow across swampy plain; the channel width is 20–25 m, the depth is 1–1.5 m. After the tributary Pana empties into Varzuga, the channel broadens to 100 m and more, and many rapid sites appear. The number of rapids increases closer to the mouth, the river being confined by rocky banks sometimes for several kilometres. The mussels were found in a 30 km stretch from the Yuziya River to the Pana River. Adult mussels were counted in a 3000x80 m sample plot at the Kichisara River mouth. The resultant number was 2 160 000 individuals, including 17.4% of young mussels.

River Pana is the right-side tributary of Varzuga. Surveys covered 152 km (including tributaries). The river valley is flat, swampy, 10 to 70 m wide. The river is populated with mussels nearly throughout. The population density in the middle reaches was up to 50 ind./m². Young mussels contributed ca. 15% to the colonies. The mussels were counted in a 3600x50 m sample plot near the Purumvuej River, and the number of mussels there was 2 340 000 ind.

CONCLUSIONS

Ten years of surveys of river systems in Northwest Russia from the south of Novgorod Region to the Barents Sea coast for the freshwater pearl mussel *Margaritifera margaritifera* have led to the following conclusions:

1. *M. margaritifera* has practically disappeared from rivers of the Novgorod, Leningrad, Arkhangelsk Regions and Karelia. Either occasional individuals or isolated colonies have survived, representing historical samples.

2. Fairly abundant populations of *M. margaritifera* still inhabit several rivers of the White and the Barents Sea watersheds. Presumably, human activities have not yet produced their effect.

3. Older data need to be compared with the state-of-the-art, especially given that the most costly work of searching for mussel populations will not be needed. The mussel habitats have been identified, and the methodology has been tried out.

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